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CC: RCB, PFF, HDP

SUBJECT: Preliminary Window Flight Test Program

I. Introduction

The purpose of this report is to outline our present feelings regarding the window flight test program, and to assist the test group and ourselves in making the necessary preparations. It is preliminary in the sense that it is recognized that the final test plan must include variables such as vehicle availability, area manpower loads, and other factors unknown at this time. This report is written with the following overall assumptions:

1. Flight tests will be conducted in two parts
   a. Cold: with present flight parameters
   b. Hot: with final flight parameters

2. Three window types will be on hand for final tests. These are:
   a. Vacuum Window
   b. Improved non-vacuum window
   c. Non-vacuum window presently in use

3. One interchangeable hatch will be available for flight tests. A vacuum window and an improved non-vacuum window will be installed in this

hatch for testing. It is planned at this time that the non-vacuum windows presently in use will not be tested as part of this program. This decision, of course, is subject to change at a future date if warrented by area conditions.

II. Objectives

The overall test objectives for both the vacuum and improved non-vacuum windows are as follows:

1. Determination (visually) of the overall effects on the window assembly resulting from exposure to flight environment.

2. Determination of overall thermal characteristics of window assembly.
   a. Heat transfer through glass and mount
   b. Lateral temperature gradients in glass

3. Adjustment of mount to minimize glass temperature gradients.

4. Measurement of vibration levels of the inner glazing in a direction normal to the window to determine effectiveness of mounting method.

5. Comparative photographs between vacuum and non-vacuum window

Additional test objectives for the vacuum window are:

1. Determination of the performance of the vac-ion pumps
2. Determination of the effectiveness of the outgassing procedures prior to flight.
3. Determination of the outgassing rate of the window during flight

4. Determination of the effect of exposure to flight environment upon window leakage rate.

Additional objectives for the improved non-vacuum window are:

1. Determination of the thermal characteristics of the window as a function of gap medium.
2. Determination of the performance of the pressure regulating system of the window.
3. Determination of the effectiveness of the RTV seal in eliminating leakage from the bay to the window gap.
4. Comparative photographs through non-vacuum window with various gap media.

III. Instrumentation

1. Temperature Measurement: Thermocouple locations for the vacuum window and the improved non-vacuum window are shown in Figures 1. Thermocouples will be copper constantan. Reference junction will be a constant temperature oven. Glass temperature measurements will be made by optically contacting to the inner glazing with small glass discs into which the thermocouples are imbedded.

All inner surface glass and mount temperatures will be monitored by one century recorder. Therange of this recorder should be 125°F - 275°F. This will yield an accuracy of approximately ±3°F. When initial measurements and adjustments have been made, the recorder range will be narrowed to the average glass temperature ±10°F. (example: if avg. glass temp. = 155°F, recorder range will be set at 145°F-165°F). This will yield an accuracy of ±0.5°F.

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2. Vacuum Measurement: Gap vacuum (for vacuum window) as a function of time will be recorded by monitoring the vac-ion pump input voltage, and recording this signal logarithmically.

3. Vibration Measurement: Vibration measurements will be made by means of an Endevco series 2219 accelerometer mounted at the center of the inner glazing.

4. Differential Pressure: Differential pressure between bay and gap (for improved non-vacuumwindow tests) will be monitored by means of a pressure transducer, the output of which will be fed into the century recorder. This measurement will enable us to determine:

a. If operation of pressure regulating system is satisfactory

b. If RTV seal is effective in eliminating bay to gap leakage

5. Real Time Recorder: The actual time at which the recorders are actuated will be recorded by means of a device which delivers a signal whose level is a function of time. This will enable us to correlate the recorded data with the flight conditions at the time the data are obtained.

IV. Overall Test Plans

1. General Procedures: One vacuum window and one improved non-vacuum will be installed in the interchangeable hatch. For the "cold" flights it is felt that little useful thermal information can be obtained, and therefore only the following data will be obtained during this period:

a. Window vacuum as a function of time

b. Vibration levels for both vacuum and non-vacuum windows

c. Differential pressure readings for non-vacuum window

d. Skin, bay and glass temperatures (single thermocouple will be placed at center of glazing).

Gap medium of the non-vacuum window for "cold" flights will be helium.

At the completion of the "cold" flight period, tests under final flight parameters (hot) will begin as described in the attached schedules. Since the available recording capability is insufficient to totally instrument both windows simultaneously, the thermal testing of the vacuum window will be done first. During this phase, however, the non-vacuum window in the hatch will be flown with various different gap media, and its inner glass temperature monitored. This will enable us to make a tentative selection of the optimum gas to use. Thermal testing of the non-vacuum window (with the chosen gas) will then commence; and if possible, comparative photographs through both windows made The non-vacuum window will then be removed and the second vacuum window installed in the hatch.

Test plans for individual flights which will include such information as when to turn on recording equipment, etc. will be written in the field on the basis of the overall flight plan for that day scheduling of flights for determination of photographic quality as a function of window type will also be done in the field. Two general statements can be made however:

a. All flights should be of minimum two hour duration to assure that steady state conditions are reached.

b. The system should not be flown at any time under flight conditions more severe than those under which the window has previously flown alone, or for which it was designed, without prior engineering evaluation of possible effects.

V. Summary

The assistance of the TestGroup in the implementation of this program, especially in procurement or setup of special equipment, would be appreciated. Along these lines, several items are noted:

1. Logarithmic recording of vac-ion voltage
2. Differential pressure recording for non-vacuum window
3. Capability to change recorder range in field to any desired values
4. Means of calibrating recorders in field easily and accurately

The attention of the Test Group is also called to the attached test schedules in which anticipated time and manpower requirements are tabulated.

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PREFLIGHT WORK SCHEDULE

Task	Estimated Time (Days)	Technidan Help Req'd	Remarks
1. Set up Support Equipment a. Leak detector station b. Pumping & outgasing station c. Purging Station	2	WGT	
2. Check condition of windows upon arrival a. Vacuum window (1.) Leak check (with leak detector) (2.) Structural examination b. Non-vacuum window (1.) Leak check (with manometer) (2.) Structural examination	1	WGT	
3. Install windows in hatch a. One vacuum & one non-vacuum	1	VP	Assuming hatch cutouts previously made
4. Wire thermocouples into plugs	1/4	ET	
5. Install reference thermocouples in oven	1/4	ET	
6. Calibrate recorders a. Known input voltage and/or reference temps. (1.) Calibration film strip	1	ET	
7. Calibrate and install real time recorder	1/2	ET	
8. Calibrate & install accelerometers & associated eqt.	1/2	ET	Calibration may already be done

WGT: Window Group Technician

VP: Vehicle People

ET: Electrical Technician

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TEST SCHEDULE-IMPROVED NON-VACUUM WINDOW (HOT TESTS)

Task	Estimated Time (Days)	Remarks
1. Install thermocouples	1/2	
2. Initial test flights		Note 1
a. Aluminum spacer & cooling fins, and:		
(1.) Helium in gap	1	Initial tests to be run
(2.) Argon in gap	1	simultaneously with
(3.) Neon in gap	1	vacuum window tests
(4.) Xenon in gap	1	
3. Review data	2	
a. Choose gas to use for further thermal tests		
b. Trim mount to reduce thermal gradients	1	Note 2
4. Test flight with above trim	1	Note 1
5. Review data	1	
a. Trim mount to further reduce gradients if required	1	Note 2
6. Change recorder sensitivity to avg. temp. $\pm 10^{\circ}F$.	1	Recalibration required
7. Test flight with new trim	1	Note 1
8. Review data	1	
a. Make final adjustment (if req'd)	1	Note 2
9. Test flight with final trim (if req'd)	1	Note 1

Note 1: Detailed test plan to be written [redacted] STAT
Note 2: Milling machine required for trimming of cooling fins.

TEST SCHEDULE - VACUUM WINDOW (HOT TESTS)

Task	Estimated Time (Days)	Remarks
1. Install thermocouples	1/2	
2. Test Run #1 (with present cooling fins)	1	Note 1
3. Test Run #2 (without cooling fins)	1	Note 1
4. Review data	2	
a. Make partial adjustment of fins	1	Note 2
5. Test Run #3 (with partial adjustment)	1	Note 1
6. Review data	2	
a. Make total adjustment of fins	1	Note 2
7. Change Recorder sensitivity to avg. temp. $\pm 10^{o}F$	1	Recalibration required
8. Test Run #4 (with total adjustment)	1	Note 1
9. Review data	2	
a. Make final adjustment if necessary	1	Note 2
10. Test Run #5 (with final adjustment)	1	Note 1

Note 1: Detailed test plan to be written [redacted] STAT
Note 2: Milling machine required for trimming of cooling fins

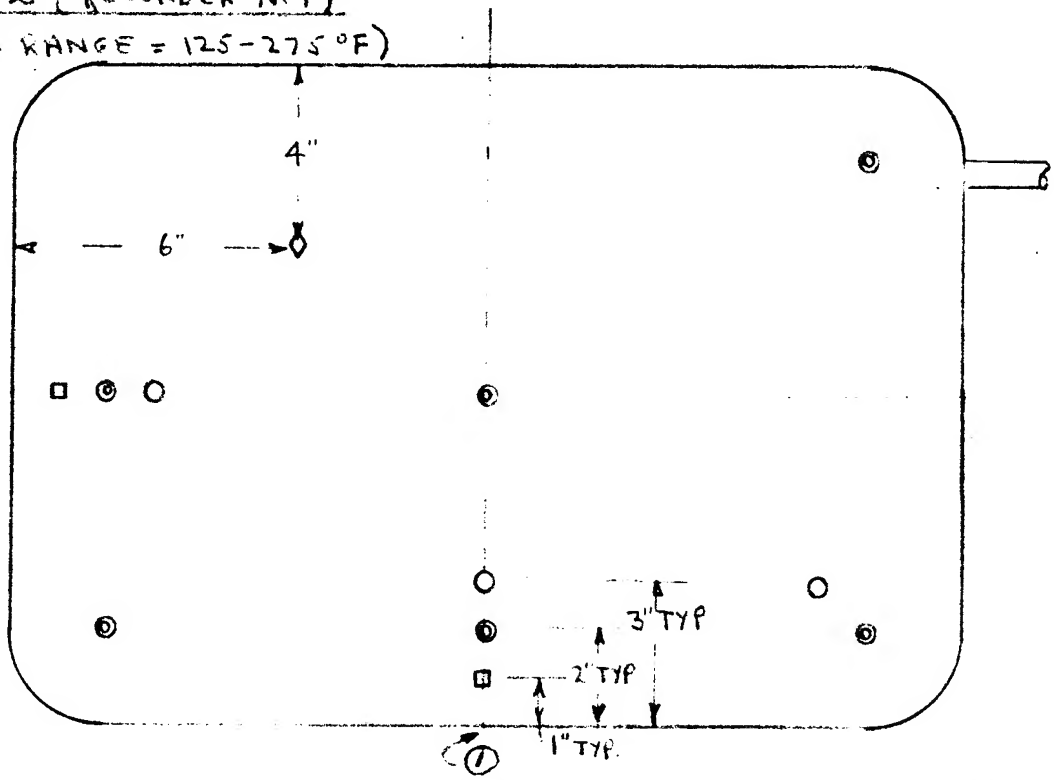
FIGURE 1

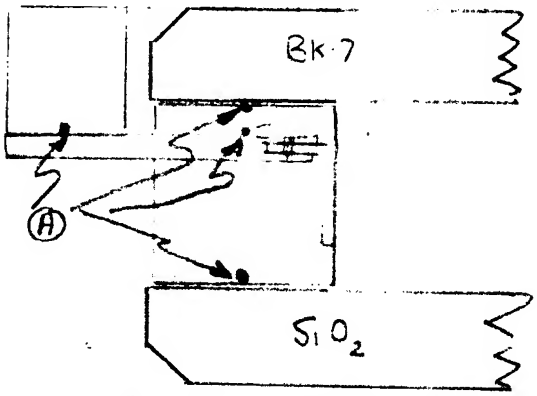
INSTRUMENTATION - VAC. & NON VAC WINDOW

GLASS THERMOCOUPLES

TOTAL = 12 (RECORDER NO 1)

(RECORDER RANGE = 125-275 °F)





MOUNT THERMOCOUPLES

CENTER OF SIDE 1 - A TC'S : TOTAL = 4

(RECORDER #2)

DISTRIBUTION OF REMAINING RECORDER CHANNELS (RECORDER # 2)

BAY TEMP TC.	1	CHANNEL
SKIN " "	1	"
BAY WALL TEMP "	1	"
ACCELEROMETER	1	"
VACULM IN GAP	1	"
REAL TIME DEVICE	1	"
GLASS TEMP OF 2nd WINDOW	1	"
DIFF. PRESSURE	1	"

TOTAL = 8

NOTE : RANGE FOR TC'S ON RECORDER NO 2 TO BE: (-20 °F) - (300 °F), WITH EXCEPTION OF SKIN TEMP CHANNEL WHICH SHOULD BE : (-20 °F) - (+550 °F)